CLAIMS

1. An obturator for use with a cannula having a bearing surface, the obturator comprising:

an elongated shaft having a first end, a second end, and an axis directed along the direction of elongation of the shaft; and

a cap assembly mounted at the second end, the cap assembly having at least one bearing surface adapted for slidably engaging the bearing surface of the cannula wherein the obturator is deflected relative to the cannula.

2. The obturator as recited in claim 1, wherein the bearing surface of the cap assembly is a surface inclined with respect to the axis of the shaft.

3. The obturator as recited in claim 1, wherein the bearing surface of the cap assembly is essentially parallel to the axis of the shaft.

4. The obturator as recited in claim 1, wherein the bearing surface of the cap assembly comprises a surface of a projection on the cap assembly.

5. The obturator as recited in claim 1, wherein the bearing surface of the cap assembly comprises a surface of a recess in the cap assembly.

6. The obturator as recited in claim 1, wherein the cap assembly is one of rectangular, triangular, circular, and ellipsoidal in coss-section.

7. The obturator as recited in claim 1, wherein the at least one bearing surface of the cap assembly comprises at least two bearing surfaces.

8. The obturator as recited in claim 1, wherein the obturator deflects in a direction essentially parallel to the axis of the shaft.

9. A trocar, comprising:

a cannula having a first end and a second end, the second end having at least one first bearing surface;

an obturator comprising an elongated shaft having a pointed end and an end comprising a cap assembly having at least one second bearing surface adapted to cooperate with the first bearing surface; and

means for slidably engaging the first bearing surface and the second bearing surface whereby the obturator is deflected relative to the cannula.

10. The trocar as recited in claim 9, wherein the means for slidably engaging the first bearing surface and the second bearing surface comprises rotating the obturator relative to the cannula.

11. The trocar as recited in claim 9, wherein at least one of the first bearing surface and the second bearing surface comprise an inclined surface.

12. The trocar as recited in claim 9, wherein at least one of the first bearing surface and the second bearing surface comprise the surface of one of a projection, a recess, and a boss.

13. The trocar as recited in claim 9, wherein at least one of the first bearing surface and the second bearing surface comprise one of a linear and a curvilinear surface.

14. A method for removing a trocar obturator from tissue, the method comprising:

rotating the obturator within and relative to a cannula to engage respective surfaces of the obturator and the cannula so as to deflect the obturator relative to the cannula; and

extracting the obturator from the tissue by withdrawing the obturator through the cannula.

15. The method as recited in claim 14, wherein the trocar comprises a cannula having at least one first bearing surface and the obturator comprises a cap assembly having at least one second bearing surface adapted to cooperate with the first bearing surface, wherein at least one of the first bearing surface and the second bearing surface comprise an inclined surface, further comprising slidably engaging the first bearing surface against the second bearing surface during the rotation to thereby axially deflect the obturator at least partially out of the tissue.

16. The method as recited in claim 14, wherein the rotating comprises rotating the obturator at least 5 degrees.

17. The method as recited in claim 14, further comprising removing the obturator from the cannula.

18. A cannula for a trocar, the cannula comprising:

an elongated cylindrical tube having a first inside diameter, a open first end, and an open second end adapted for receiving an obturator; and

wherein the open first end is flexible and internally tapered from the first inside diameter to a second inside diameter, smaller than the first inside diameter.

19. The cannula as recited in claim 18 wherein the tube has a first outside diameter and the open first end is externally tapered from the first outside diameter to a second outside diameter, smaller than the first outside diameter.

20. The cannula as recited in claim 19 wherein the second inside diameter is essentially the same as the second outside diameter.

21. The cannula as recited in claim 18 wherein the material of the open first end is one of a thermoplastic polymer and a thermoset polymer.

22. A trocar comprising:

an obturator comprising an elongated shaft having an axis and an outside diameter; a first end having a tip adapted for insertion into tissue, the first end having a maximum diameter; and a second end; and

a cannula having an open first end having an inside surface and a first inside diameter, and an open second end adapted for receiving the obturator;

wherein the inside surface of the first end of the cannula is flexible and the first inside diameter of the first end of the cannula is smaller than the maximum diameter of the first end of the obturator.

23. The trocar as recited in claim 22, wherein the inside surface of the first end of the cannula is uniformly tapered from a second inside diameter, larger than the first inside diameter, to the first inside diameter.

24. The trocar as recited in claim 22, wherein the first inside surface of the first end of the cannula is smooth and continuous.

25. The trocar as recited in claim 22, wherein the first end of the obturator comprises a first tapered surface extending from the maximum diameter of the first end to the tip.

26. The trocar as recited in claim 22, wherein the first end of the obturator comprises a second tapered surface extending from the maximum diameter to the outside diameter of the shaft.

27. A method for removing an obturator from a trocar, the method comprising:

providing an obturator having an elongated shaft and a tip, the tip having a first diameter;

providing a cannula having an elongated tube, the tube have a flexible open end having an inside diameter, the inside diameter being less than the first diameter of the tip of the obturator;

holding the cannula in a relatively stationary position;

radially deflecting the open end of the cannula to increase the inside diameter of the open end;

passing the tip of the obturator through the increased inside diameter of the open end of the cannula; and

withdrawing the obturator from the cannula.

28. The method as recited in claim 27 wherein the radially deflecting the open end of the cannula comprises impinging the tip of the obturator against the inside diameter of the open end of the cannula.

29. The method as recited in claim 27, wherein the radial deflection of the open end of the cannula comprises an elastic deflection.

30. The method as recited in claim 27, wherein the cannula further comprises at least one first bearing surface and the obturator further comprises at least one second bearing surface adapted to cooperate with the first bearing surface, wherein radially deflecting the open end of the cannula comprises:

rotating the obturator relative to the cannula;

slidably engaging the first bearing surface against the second bearing surface whereby the obturator is deflected relative to the cannula; and

impinging and deflecting the inside diameter of the open end of the cannula with the tip of the obturator.

31. A trocar comprising:

a cannula having a first end and a second end, the first end having an outside surface and an inside diameter, the second end having a head assembly, the head assembly having at least one first bearing surface; and

an obturator comprising a shaft, a first end having a tip, a second end, and an axis directed along the direction of elongation of the shaft; the first end of the obturator having a maximum diameter, a first tapered surface extending from the maximum diameter to the tip, and a second tapered surface extending from the maximum diameter to the outside diameter of the shaft; the second end of the obturator having a cap assembly, the cap assembly having at least one second bearing surface adapted for slidably engaging the first bearing surface of the cannula head assembly;

wherein at least one of the first bearing surface and the second bearing surface are inclined relative to the axis of the obturator whereby when the obturator is rotated about its axis, the second bearing surface slidably engages the first bearing surface and axially deflects the obturator whereby the second tapered surface of the first end of the obturator impinges and deflects the inside diameter of the first end of the cannula whereby the maximum diameter of the obturator can pass through the open first end of the cannula and the obturator can be removed.

32. A method of using a trocar, the trocar comprising an obturator having a tip and a cannula having a flexible open end, the method comprising:

inserting the trocar into a body cavity;

slidably engaging a bearing surface on the cannula against a bearing surface on the obturator thereby deflecting the obturator relative to the cannula;

impinging the tip of the obturator against an open end of the cannula and enlarging the open end of the cannula;

passing the tip of the obturator through the enlarged open end of the cannula; and

withdrawing the obturator from the cannula.

33. The method as recited in claim 32 wherein slidably engaging the bearing surfaces is practiced by rotating the obturator relative to the cannula.

34. The method as recited in claim 32 wherein the bearing surface on the cannula is moveable relative to the cannula.

35. The method as recited in claim 32 wherein the bearing surface on the obturator is moveable relative to the obturator.

36. The method as recited in claim 32, further comprising passing surgical instruments through the cannula into the body cavity.

37. The method as recited in claim 32, wherein the deflection of the obturator relative to the cannula is an axial deflection.

38. The method as recited in claim 37, wherein the axial deflection deflects the obturator out of the body cavity.

39. The trocar as recited in claim 31, wherein the outside surface of the first end of the cannula is smooth and continuous.

40. The method of claim 27, wherein the open end of the cannula tube is smooth and continuous.

41. The cannula as recited in claim 18, wherein the second inside diameter is smooth and continuous.

42. The method as recited in claim 27, wherein the cannula further comprises at least one first bearing surface and the obturator further comprises at least one second bearing surface adapted to cooperate with the first bearing surface, wherein the radially deflecting the open end of the cannula comprises:

slidably engaging the first bearing surface against the second bearing surface whereby the obturator is deflected relative to the cannula; and

impinging and deflecting the inside diameter of the open end of the cannula with the tip of the obturator.

43. The method as recited in claim 42, wherein the first bearing surface is moveable relative to the cannula.

44. The method as recited in claim 42, wherein the second bearing surface is moveable relative to the obturator.

45. The obturator as recited in claim 1, wherein the bearing surfaces slidably engage when the obturator is rotated relative to the cannula.

46. The obturator as recited in claim 1, wherein the bearing surface on the cap assembly is moveable relative to the cap assembly.

47. The obturator as recited in claim 46, wherein the bearing surface on the cap assembly comprises the surface of one of a wedge, a lever, a cam, a bar, a linkage, and a screw.

48. The trocar as recited in claim 9, wherein the first bearing surface is moveable relative to the cannula.

49. The trocar as recited in claim 9, wherein the second bearing surface is moveable relative to the obturator.

50. The trocar as recited in claim 48, wherein the first bearing surface comprises the surface of one of a wedge, a lever, a cam, a bar, a linkage, and a screw.

51. The trocar as recited in claim 49, wherein the second bearing surface comprises the surface of one of a wedge, a lever, a cam, a bar, a linkage, and a screw.

52. The cannula as recited in claim 18, wherein the open second end includes a flexible seal.

53. The cannula as recited in claim 52, wherein the flexible seal permits the passage of the obturator with little or no fluid leakage.

54. The trocar as recited in claim 31, wherein the head assembly includes a flexible seal which permits the passage of the obturator with little or no fluid leakage.

55. A cannula for use with an obturator, the cannula comprising:

a cylindrical tube having a first end and a second end;

a head assembly mounted to the first end of the cylindrical tube; and

a resilient sealing element mounted in the head assembly having at least one aperture;

whereby when the obturator is inserted into the cannula, the obturator passes through the at least one aperture in the sealing element whereby little or no fluid escapes from the cannula to the ambient environment.

56. The cannula as recited in claim 55, wherein the at least one aperture is at least two apertures.

57. The cannula as recited in claim 55, wherein the sealing element includes at least one membrane and the at least one aperture comprises a slit in the membrane.

58. The cannula as recited in claim 55, wherein the sealing element is made from at least one of silicone rubber, polyurethane elastomer, neoprene or thermo plastic elastomer.

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